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SITE REQUIREMENTS OF BLACK LOCUST

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Because black locust occurs naturally on many kinds of soil and is commonly found even on dry, infertile ridges, it has been classified generally as a species very indifferent to quality of site. From the standpoint of its ability to establish itself and exist, this is true, and therefore locust is admirably adapted for planting on eroded lands. From the standpoint of rapid growth, profitable yield of wood products, and resistance to locust borer attack, however, this conception of black locust site requirements must be very greatly modified. Like most other tree species, it makes its best growth on deep, fertile, moist but well-drained soils. Data gathered from the examination of more than one hundred plantation plots, selected for study throughout the Central States and in adjacent regions, provide for a better understanding of black locust's adaptability to various conditions of soil and site.

Soil Classification. Accurate and detailed soil surveys have been made for many counties of the Central States, and it might be expected that recommendations for planting black locust, or any other tree, might be based entirely upon soil classification. This assumption is only partially correct, for there are many local variations within a soil type that influence plant growth. Trees are sensitive to soil changes, particularly to local underground conditions affecting moisture and drainage, which cannot be shown on a soil type map.

For instance, the Clermont silt loam of southern Indiana is generally unfavorable to the best growth of black locust, but local areas occur where the subsoil conditions enable this species to grow very well. In general, the Tama silt loam of Iowa is favorable to locust growth, yet unfavorable local sites within this soil type are by no means uncommon. The physical factors of soil structure, condition of the subsoil, and drainage are very important in locust site determination, and may have far more influence on growth than fertility and other factors characteristic of a soil type. For this reason, any accurate classification of site must be made for each individual area in accordance with the requirements of the tree species.

Definition and explanation of several terms commonly used in soil science are necessary for a clear understanding of the discussion of site requirements of black locust.

Soil texture refers to the size of the particles, such as sand, silt, or clay. Texture may be determined readily by the feel when soils are rubbed in the hands: sands are gritty, pure silts are smooth without stickiness, and clays are slick and sticky when wet. Various combinations of these textures may be approximately evaluated.

Soil structure is the arrangement of the soil particles and is evidenced by porosity, compactness, and fracture. Soils with a loose, porous structure are composed of sponge-like lumps which crush readily and often feel gritty. Soils with a tight or dense structure are usually composed of hard, compact lumps which are difficult to crush in the hand, and break up into irregular, angular fragments. When wet, they feel slick and sticky; when cut with a knife they present a shiny, waxy surface, often with a mosaic appearance. Coarse textured soils usually have a loose structure which is favorable to tree growth, whereas fine textured soils often have a tight structure, which is unfavorable. Structure may undergo drastic changes. For instance, a virgin soil under a forest, with abundant organic matter and a protective cover of leaf litter, is generally loose and porous in structure; following clearing, excessive cultivation and cropping, with subsequent exposure, leaching and erosion, porosity is largely lost and the soil becomes compact and dense in structure. Loose soils are often severely compacted by the trampling of livestock.

A soil horizon is a horizontal layer of soil differentiated from that above or below in color, texture, or structure. A vertical section displays the soil profile, which is the arrangement of successive soil horizons, one over the other.

FACTORS INFLUENCING LOCUST SITES

Soil Structure. Of all the physical properties of soil, that of structure apparently exerts the greatest influence upon tree growth. Compactness of a soil, particularly a tight subsoil, is invariably detrimental to the growth of black locust. A dense structure lessens water absorption and moisture-holding capacity, reduces drainage and aeration, and makes the penetration of roots very difficult. It has been observed repeatedly that locust roots grow downward to a tight soil horizon and there stop, rarely penetrating it. If this tight subsoil lies only a foot or two below the surface, the top soil remains undrained and excessively wet during rainy periods, and becomes abnormally dry during periods of drought. Either condition is unfavorable to the optimum growth of black locust. On the other hand, a loose, porous structure is conducive to drainage and aeration and permits what has been termed rootilation - that is, tubular porosity caused by the penetration of the roots and fine rootlets. As a result of their penetration and decay over long periods of time, such a soil becomes sponge-like.

Color of Subsoil and Its Significance. The color of the subsoil in itself is probably not important, but it is an indication of a very significant condition: namely, its state of aeration, drainage, and oxidation. The surface of the soil water-table fluctuates between fairly definite levels during the year. The submersion level is the point where much of the finer soil material is deposited from above by illuviation. This action over long periods of time creates a tight subsoil layer. As deposition and tightening increase, air has more difficulty in penetrating the soil, and a reduced condition develops. A reduced soil is likely to be drab or blue in color because of reduced oxides, whereas an aerated or oxidized soil is likely to be brown or red-brown because of the higher state of oxidation. Trees need oxygen in the soil for important nutritive processes and the state of oxidation may be judged roughly by observance of soil color.

A scale of colors used in the examination of soil profiles proves very helpful in the determination of sites suitable or otherwise for the growth of locust. The scale is as follows:

1. Red-brown - Excellent site
2. Yellow-brown - Very good site
3. Brown-yellow - Good site
4. Yellow - Medium site
5. Drab and Yellow - Medium site
6. Drab and blue - Poor site
7. Blue - Very poor site

This scale applies particularly to the subsoil because the subsoil seems to be the critical horizon as far as locust growth is concerned. The better sites were almost invariably found on soils having brown or reddish-brown subsoils. Soils having drab or drab and blue subsoils were practically always poor sites, regardless of the condition of the topsoil.

Drainage. Good soil drainage is necessary for the best locust growth. Any soil which does not permit free removal of surface water, a condition that commonly occurs on flat areas of tight soils and on low lands, is not suited to good locust growth. Such a soil remains wet and cold in the spring and is likely to become excessively dry and baked in the summer. A poorly-drained soil does not permit enough air to enter to allow for proper decomposition of organic material and adequate elaboration of plant food.

A dry, exposed sandy or shale ridge with excessive drainage likewise offers a poor site for locust, although it may exist there and grow slowly. Sandy soil, however, may be excellent if the water table is near the surface, or if the site is on a sheltered slope where seepage from above supplies the needed moisture. Sand soils as a rule become very dry during periods of drought and locust will not flourish in any soil which dries out excessively. Following the previous discussion of subsoil color, it must be remembered that sand soils are likely to be brown in color, well oxidized and drained, yet they may be poor sites because of extreme dryness. The same is likely to apply also to shallow soils over rock or shale.

Aspect and exposure influence site quality. A southern exposure may induce dryness of site unfavorable to locust growth, and the prevalence of strong winds on an exposed ridge frequently has a detrimental influence.

Soil Fertility. Fertile soils with abundant organic matter and necessary mineral elements available for plant growth, naturally provide the best sites for black locust, if the physical properties of the soil are also favorable. This study has clearly established the fact that soil fertility alone is no final criterion of locust site quality. The best locust stands were not always found on the most fertile sites, as judged from the agricultural viewpoint; some of the poorest stands were found on soils whose surface was very fertile. A loose, light soil of inferior fertility may provide a site much better than a black, fertile topsoil underlain with a tight subsoil. The presence of organic matter is undoubtedly helpful in supplying plant food, in holding moisture, and in improving the structure of the surface soil; but if the moisture relationships of the site are upset by a clay-pan, or by a dense, waxy clay subsoil of poor structure, organic matter on the surface will not ensure good locust growth.

After two seasons' field work and observations of black locust stands, it has not been established that soil reaction is an important influence on site quality. Investigations included electrometric measurements in the field of some 500 soil horizons, and the conclusion reached is that there is no apparent correlation between site quality and soil acidity or alkalinity. Good sites were found on both acid and sweet soils; likewise poor sites were found on limestone and siliceous soils. A similar lack of correlation with soil reaction was found by Dr. A. G. Chapman of Ohio State University in his investigation of nitrogen-fixing nodules on the roots of black locust.

The Influence of Erosion on Site. The foregoing discussion of soils and sites favorable or otherwise to black locust will prove helpful to tree planters whose primary purpose is the growing of profitable crops of this species. In planting locust for erosion control, however, the planter is forced to accept a given site which may prove unfavorable to that species. Even in such instances it has been shown that the use of this tree, usually in mixture with other species, is advisable.

In the past, tree planters have been told that it is usually safe to plant native trees which formerly occupied the site, or which grow well on nearby lands of a similar character. Studies of forest sites in the Central States have now shown that this is not always a safe rule to follow. Following the clearing and cultivation of forest lands, changes in soil due to erosion, leaching and excessive cropping often result in sites very unfavorable to tree growth. In some localities erosion quickly removes loose surface soil and the exposed surface becomes compacted by rain and clogging of the soil pores. In many instances the topsoil is entirely washed away and only the subsoil is left. Such a condition makes the establishment of young trees very difficult or impossible. Seedlings are exposed to the hot summer sun on a soil surface that bakes and cracks. Under such conditions even black locust, which endures such hardships better than most other hardwood species, has difficulties in surviving.

On the other hand, there are extensive areas of deep, unconsolidated or loessal soils where erosion is usually very severe, and yet the quality of the site for black locust has apparently been little impaired. This study has shown that site quality is not dependent in a large measure upon the thickness of the surface soil horizon, provided that subsoil, drainage, and other conditions are favorable. From the data of surface horizon thicknesses measured on 116 plantations, site quality indexes for the same sites failed to show any correlation. This does not mean that eroded land is as good as it was before the surface horizon was washed off, but it does show that the effect of a tight under-horizon is so significant that mere thickness of the surface soil is of secondary importance. A soil may have a 24-inch upper horizon - black, fertile and loose; but if under it is a tight clay horizon, the site may be poorer than one with a 2-inch upper horizon and a friable, well-aerated subsoil horizon. Fortunately hilly land, where erosion is most severe, usually has a fairly well oxidized and aerated subsoil. It has natural drainage and is seldom water-logged.

Locust will make some growth on nearly any soil, and from the standpoint of its use for erosion control, this is very fortunate; but if profitable returns from locust products are the chief consideration for planting, the site must be as carefully selected as for many other species.